

# Design of Signalized Intersections:

## Guideline and Checklist

Prepared by:  
Utah Department of Transportation



**Division of Traffic & Safety**  
Signal and Lighting Design

**Updated: 3/1/04**

## TABLE OF CONTENTS

Division of Traffic & Safety .....	0
TABLE OF CONTENTS.....	1
SYMBOL LEGEND .....	1
1.0 GENERAL.....	2
2.0 GENERAL PLAN INSTRUCTIONS .....	2
2.1 TITLE BLOCK .....	2
2.2 PLAN SHEET NUMBERING.....	4
2.3 NORTH ARROW .....	5
3.0 TRAFFIC SIGNAL DESIGN.....	5
3.1 SIGNAL POLES .....	5
3.2 SIGNAL HEADS.....	5
3.3 LEFT-TURN LANES .....	6
3.4 TRAFFIC DETECTOR LOOPS.....	6
3.5 RELATING DETECTOR LOOPS TO SIGNAL PHASING .....	14
3.6 NEMA PHASE DETAIL .....	16
3.7 LUMINAIRE EXTENSIONS.....	17
3.8 LANE LINES AND INTERSECTION STRIPING.....	17
4.0 CIRCUIT DESIGN.....	17
4.1 SIGNAL CIRCUITS .....	17
4.2 CONDUIT .....	19
4.3 JUNCTION BOXES .....	20
4.4 POWER SOURCE .....	20
4.5 GROUND RODS .....	21
4.6 CONTROLLER AND CABINET.....	21
5.0 OTHER CONSIDERATIONS .....	21
5.1 TEMPORARY OPERATION.....	21
5.2 SIGNAL TURN-ON .....	21
5.3 INTERCONNECT .....	22
5.4 SINGLE POINT URBAN INTERCHANGE (SPUI) .....	22
5.5 VIDEO DETECTION .....	23
5.6 MISCELLANEOUS.....	24
APPENDIX.....	25
A.1 STANDARD SIGNAL REFERENCE.....	25
A.2 CONTACT LIST.....	26
A.3 UDOT WEBSITE INFORMATION AND DOWNLOADS: .....	26
A.4 STATE FURNISHED MATERIAL REQUISITION PROCESS .....	27

## SYMBOL LEGEND



Denotes an important piece of information, idea, or concept.



Denotes a new procedure, idea, or concept.

## 1.0 GENERAL

This guideline is given as a general instruction primer and is intended to supplement good judgment, engineering design, and common sense. It must never be used as a substitute for them.



Each intersection has unique characteristics that must be considered for appropriate signal design. When designing a traffic signal always include a site visit during the scoping/kickoff meeting to determine the design parameters and a second visit during the design process to check the design. Make note of grade considerations both on the road and behind curb & gutter (where the pole will be located). Try to avoid conflicts with existing utilities including overhead lines. Drainage is always an issue at intersections. For safety and roadway efficiency provide for the removal of any drainage water so a minimum of 20 mph speed can be maintained through the intersection. Remember you are designing (describing) a three-dimensional product in a two-dimensional plan set.

All intersections should be designed as fully actuated. The Utah Department of Transportation utilizes fully actuated signal systems through the implementation of in-pavement detector loops or video detection.

The proposed intersection should be designed to meet a Level of Service (LOS) “D” or better based on 20-year projected traffic volumes. Intersection LOS analysis may be facilitated by using computer programs such as: SIG/CINEMA; SYNCHRO; TRANSYT-7F; or PASSER II.

Develop a signal timing plan for each signal location based on existing traffic volumes. The signal timing plan should be included on the Signal Plans and is used for the initial field setup of the signal controller.

The Division of Traffic & Safety warrants traffic signals throughout the State. Signal Warrant documentation includes a warrant memo with the current directional volume counts including peak hour volumes, warrant analysis, and an Operational Safety Report (OSR). This information is available upon request (refer to the contact list at the end of the guidelines).

## 2.0 GENERAL PLAN INSTRUCTIONS

The following are general instructions to be used as a guideline in laying out the plan sheets. The signal sheets are to be in 1”=20’, or at a common scale that best suits the intersection. CADD system 11”x17” reduced plan sheets will be plotted at 1”=40’ scale.

### 2.1 TITLE BLOCK

The four lines in the title block contain the following information:

The **first and second line** of each title identifies the Project Name.

The **second line** of each title block identifies the location, and includes the address and city.

The **third line** of each title block identifies what information the sheet contains.

Example: SIGNAL PLAN  
SUMMARY SHEET  
DETAIL SHEET

The **fourth line** is for the project number.

Include the following individual design sheets for every signal location in the project:

Topo-R/W-Utilities

Plan Sheet

Identify the Topo, Utilities, Right of Way and display the signal poles. Check overhead clearance for mast arms and lighting extensions.

**NOTE:** The size and type of utilities should be listed, not just “Gas Line” but “6 inch High-Pressure Gas Line”.

Striping and Signing

Plan Sheet

Include all pavement striping, pedestrian access ramp locations and signing.

Traffic Signal Plan

Plan Sheet

Describe the traffic signal design. Include the length of the mast arms, the location of the traffic and pedestrian signal heads in relation to the lane lines. Identify light pole or luminaire placement, detector loops or video camera placement, and phasing diagram. Show utilities that may conflict with pole placement.



**NOTE:** Intersections where there is no possibility of an opposing left turn, (“T” intersection) lagging left-turn phasing may be preferred. A separate sheet may be required for the phasing diagram.

Detector Circuit

Plan Sheet

Describe the layout of the detector loops or video cameras, junction boxes, number and sizes of conduits, and the number and routing of the home runs.

Signal Circuit

Plan Sheet

Describe the layout of the junction boxes, the number of and size of conduit, lighting, power source and signal circuit cables, and future use conduit, if applicable. This may require more than one sheet.

Interconnect

Plan Sheet

Describe the interconnect layout and details. This sheet follows the numbering of the last intersection, if applicable.

## 2.2 PLAN SHEET NUMBERING

Sheet numbering includes a letter code that identifies the type of sheet. The appropriate code letter is placed before the consecutive sheet numbering, e.g., RD-1, RD-2, RD-3, etc. Include only codes applicable to the signal project and eliminate all others that are not needed.

Sheet 1's (e.g. title sheet, 1A-plan sheet codes and descriptions, 1B-index to plan sheets, 1C and 1D-index to standard drawings, 1E-storm water pollution prevention plan, etc.) Do not require a sheet identification code.

<u>ID CODE LETTER</u>	<u>SHEET NAME</u>
1	Title Sheet
1A	Plan Sheet Codes and Descriptions
1B	Index to Plan
1C-1D	Index to Standard Drawings
1E	Storm Water Pollution Prevention Plan
TS	Typical Sections
DT	Details - which may include minor structures if no structure number is required.
SM	Summary - (not for signal summaries)
TC	Traffic Control (Use only when paid for by individual items)
RD	Roadway Plan
RP	Roadway Profile
PP	Plan and Profile - Use for small projects that can combine all information on the same sheet.
UT	Utility/Topography
UR	Utility Relocation
RR	Railroad
GR	Grading
DR	Drainage
IR	Irrigation
EC	Erosion Control
LS	Landscaping
WM	Wetland Mitigation
SS	Signing and Striping
SG	<b>SIGNAL</b> – SG-xx for Signal Plan Sheets, SG-Sx... for Signal Summaries.
	When a project has more than one signal intersection, individual intersections are numbered with a letter at the end, such as: SG-1A thru SG-9A and SG-1B thru SG-9B, etc.
SI	Signal Interconnect
LT	Lighting
AT	Advance Traffic Management System
RW	Right of Way
MS	Material Site
—	Structures Drawings
—	Standard Drawings



## 2.3 NORTH ARROW

When signalized intersections are included as part of a roadway project, orient the north arrow in the same direction as the intersection on the roadway plans. For individual signal projects orient the north arrow towards the top of the sheet. Refer to the latest version of the UDOT CADD Standards for the proper cells.

## 3.0 TRAFFIC SIGNAL DESIGN

### 3.1 SIGNAL POLES

**Pole Numbering** – The pole numbering starts with the pole in the upper left-hand corner as number P1, and continues clock-wise around the intersection.

**Placement** – Signal poles should be located as close to the center and back of the corner and pedestrian ramps as possible, considering the underground and overhead utilities. Push buttons must be no greater than 10' from pedestrian ramp TBC line. A supplemental pedestrian pole may be required.

Overhead clearance is very important where 30-foot or 40-foot luminaire extensions are used. Maintain minimum clearance from primary conductors to luminaire. Contact Utah Power for required safe working clearances. We now have the option of using a vertical luminaire extension that may help in avoiding these conflicts.

When dual mast arms are used, the length of arm is limited to 45 ft. for each arm to avoid overloading the foundation.



**NOTE:** A specific signal pole is required for two different ranges of mast arm length. The bolt circle at the mast arm connection in each range is the same. A special pin welded to the 50' to 75' arms prevents the accidental installation of a long arm on the dual mast arm signal pole. The two ranges are as follows:

- 25 ft. to 65 ft. mast arms
- 70 ft. and 75 ft. mast arms

**NOTE:** All signal poles now require the same 23- inch anchor bolt circle. Refer to Standard Drawing SL-4 for the detail.

### 3.2 SIGNAL HEADS



Proper placement of signal heads over the roadway dictates the length of mast arm used and to some extent the location of the pole foundation. The standard mast arm length is 25 ft. to 65 ft. (available in five-foot increments). For wide roadways or special circumstances a 70 ft. or 75 ft. mast arm may be specified.

**NOTE:** A supplemental near-side signal face is required for signal heads located more than 150 ft. from the stop bar. **Signal Head Placement:**

- Apply good engineering judgment when determining signal head placement.
- Provide at least two signal heads for the major movement.
- Place the signal heads no closer than 8 ft. apart. Refer to Standard Drawing SL 1A and SL 1B for standard head mounting locations.
- Do not locate the right most signal head over the shoulder or a curb line.
- Use signal head bracket mounts to mast arm per Standard Drawing SL 2.
- Provide 17'-6" clearance from bottom of signal head or back plate to roadway surface.

**Through Movement Signal Heads:**

- Place the left most through signal head 3 feet to the right of the dividing line between opposing traffic as you look across the intersection.

**Left-Turn Signal Heads:**

- **Exclusive/Permissive Left** – Place the signal head regulating the left-turn movement 3 ft. to the right of the dividing line between opposing traffic as you look across the intersection.
- **Single Dedicated Left** – Place the signal head regulating the left-turn movement over the center of the opposing left-turn lane.
- **Dual Left** – Place the signal head regulating the left-turn movement between the two left-turn lanes. Specify a mast arm mounted dual left-turn sign (Modified R3-8).

**LED Lenses:**

Specify LED lenses for all traffic and pedestrian signal heads. If intersection has relatively new signal equipment that will remain in service, retrofit the existing heads with new LED lenses.

### 3.3 LEFT-TURN LANES

**Width** – Provide 12 ft. wide left-turn lanes. If this is not possible discuss the issues with the Region Traffic Engineer. Never exceed 12 ft. for Permissive or Exclusive/Permissive left-turn lanes. Provide a minimum 16 ft. receiving lane width for single left-turn movements (measured from the tangent section of lip of curb & gutter). Provide 30 ft. receiving lane width for dual left-turn movements.



**Alignment** – Align the left-turn lanes through an intersection to enable the driver to see past the vehicle in the opposing left-turn lane. **Left-turn lanes should not encroach on through lane alignment.**

**Length** – Design the length of the left-turn lane to accommodate the queue volume without backing traffic into the through lane. Design raised island storage to be as long as practical to not affect the efficiency of the through movement.

### 3.4 TRAFFIC DETECTOR LOOPS

The detector loop is the sensing element of the detection system. It is formed by wrapping multiple turns of single conductor stranded wire in PVC Conduit (trenched), or a saw slot around the loop perimeter. This area of the traffic lane becomes the detected zone.

The **lead-in** is the continuous wiring between the loop in the street and the junction/splice box.

This wire is splice free from start to finish and is the same single conductor wire that makes up the loop. Extended to the edge of the road for hook-up.

To reduce noise pick-up and the formation of stray electrical fields that may produce unwanted detection points the lead-in wires must be twisted about themselves. For saw-cut installations 1 twist per foot is required. For PVC conduit installations provide at least 3 twists per foot.



**NOTE:** Regardless of how lines are drawn on plans, each loop and lead-in shall be contained in its individual and separate PVC conduit to the junction box.

The **home run** is that portion of the detection system that connects the detector loops in the street (which have been run to the junction box on the side) to the controller cabinet. Twisted pair, two-conductor shielded wire is used. Each detector group shall have a separate homerun cable and amplifier channel in the traffic signal cabinet. The junction box loop wire connections are **the only traffic signal field wire splices allowed**.

<u>Detector Type</u>	<u>Loop Size</u>
Lane Detectors	6 ft. x 6 ft.
Q-Loops	6 ft. x 12 ft.
Dilemma Zone	6 ft. x 6 ft.



**NOTE:** Lane widths less than 10 ft. require additional consideration to reduce the loop size or placement to avoid interference with adjacent lanes. Never use a detector loop smaller than 4.5 ft. wide.



Placement – Please see Figures 1-5 below for a detailed description of the recommended detector placements for each approach of the intersection. The detector placements are based on the 85<sup>th</sup> percentile approach speed to the intersection (as opposed to the posted speed limit). The Figures take into account the dilemma zones for the approach.

Figure 1 – Vehicle Detector Placement for Low Speed Intersection Approach (35 MPH or less)  
 Figure 2 – Vehicle Detector Placement for Moderate Speed Intersection Approach (40 MPH)  
 Figure 3 – Vehicle Detector Placement for Moderate to High-Speed Intersection Approach (45-50 MPH)

Figure 4 – Vehicle Detector Placement for High-Speed Intersection Approach (55-70 MPH)  
 Figure 5 – Vehicle Detector Placement for Left & Right Turn Intersection Approach

The detector locations on the detector placement figures are measured from the stop bar edge closest to the detectors to the beginning of the loop detector. Pay special attention to the notes listed on each of the figures, since they will provide valuable information in respect to the specific detector diagram for the figure.

Pay special attention to intersections with non-standard geometrics. Place loops so they operate in the "non-lock" mode. Apply good engineering judgment for additional loops as needed where vehicles may be prone to stop ahead of the stop bar.

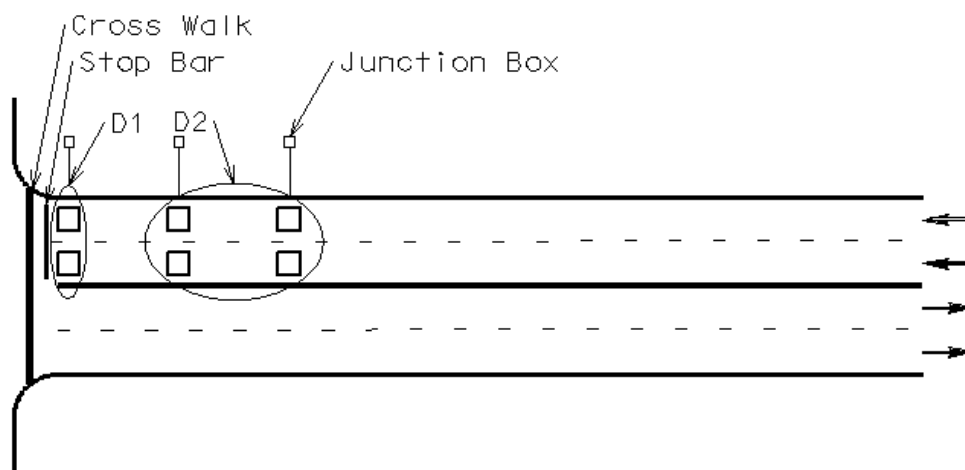


If circular loops are used for queue loops, then two loops may be placed 3 ft. apart to constitute a queue loop. Consider using pre-formed loops for rotomill and overlay projects.

Design stop bar and pedestrian crossing lines to be generally parallel to the associated roadway. When the angle between the intersecting streets is not perpendicular specify stop bar loops that are parallel to the stop bar. This stop bar detector loop may become a parallelogram in order to remain parallel with both the lane and the stop bar. The other detector loops (non-stop-bar) remain square to the through lane pavement markings.

If a detector loop location is in conflict with a manhole, water valve, etc., adjust the loop placement forward or backward in the shortest direction from the optimum position.

**Figure 1 – Vehicle Detector Placement for Low Speed Intersection Approach (35 MPH or LESS)**



Notes:

1. Each detector group shall have a separate homerun cable and amplifier channel.
2. No more than 4 detector loops shall be hooked up to the same homerun cable or amplifier channel on a minor street & no more than 6 loops on an arterial street.

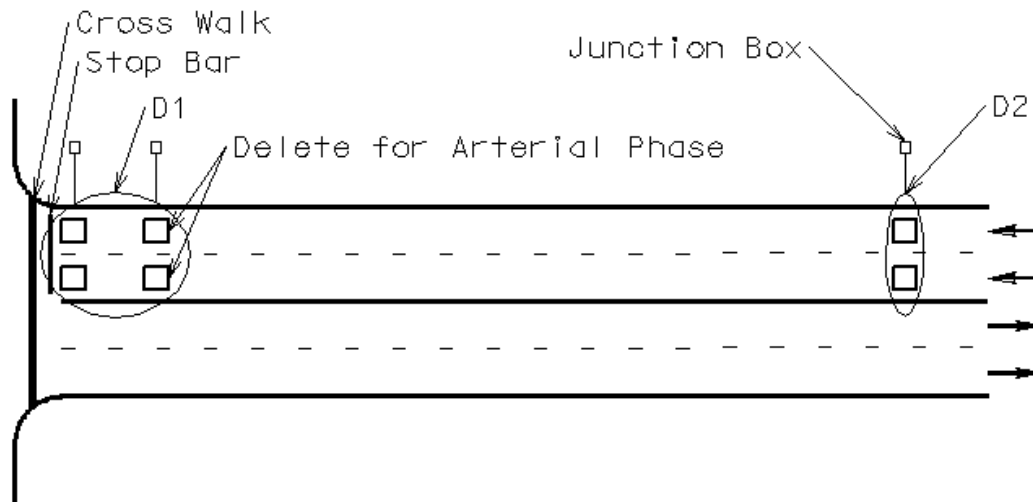
DETECTOR FUNCTIONS:

A = Normal or Standard

SPEED (MPH)	LOCATION			DETECTOR GROUP #	DETECTOR FUNCTION	INDUCTANCE LOOP SIZE
	D1	D2				
25	3'	34'	65'	D1	A	6' x 6'
30	3'	39'	75'	D2	A	6' x 6'
35	3'	44'	85'			

Location = distance from stop bar edge closest to detectors to beginning of detector

**Figure 2 – Vehicle Detector Placement for Moderate Speed Intersection Approach (40 MPH)**



Notes:

1. Each detector group shall have a separate homerun cable and amplifier channel.
2. The rear detectors for detector group D2 may be omitted if the phase is an arterial on vehicle recall.
3. No more than 4 detector loops shall be hooked up to the same homerun cable or amplifier channel on a minor street & no more than 6 loops on an arterial street.

**DETECTOR FUNCTIONS:**

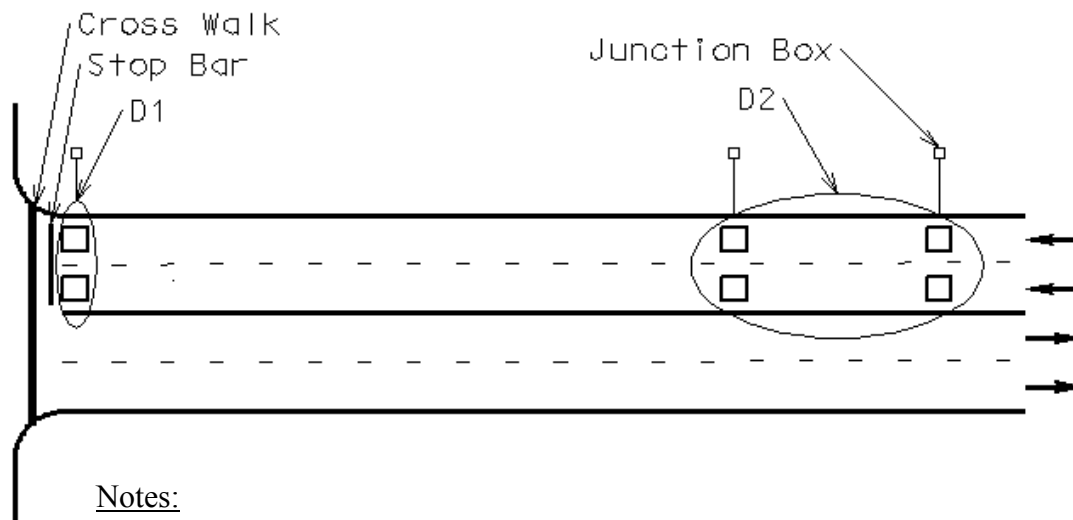
A = Normal or Standard

B = Stop Bar with Extend Timer Reset

SPEED (MPH)	LOCATION			DETECTOR GROUP #	DETECTOR FUNCTION	INDUCTANCE LOOP SIZE
	D1		D2			
40	3'	24'	250'	D1	B	6' x 6'
				D2	A	6' x 6'

Location = distance from stop bar edge closest to detectors to beginning of detector

**Figure 3 – Vehicle Detector Placement for Moderate to High-Speed Intersection Approach (45-50 MPH)**



Notes:

1. Each detector group shall have a separate homerun cable and amplifier channel.
2. No more than 4 detector loops shall be hooked up to the same homerun cable or amplifier channel on a minor street & no more than 6 loops on an arterial street.

**DETECTOR FUNCTIONS:**

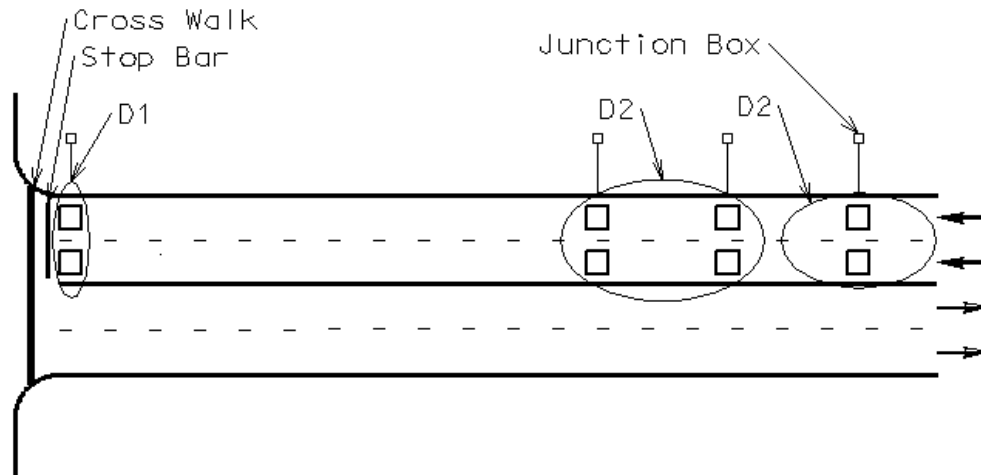
A = Normal or Standard

B = Stop Bar with Extend Timer Reset

SPEED (MPH)	LOCATION			DETECTOR GROUP #	DETECTOR FUNCTION	INDUCTANCE LOOP SIZE
	D1	D2				
45	3'	200'	300'	D1	B	6' x 6'
50	3'	230'	350'	D2	A	6' x 6'

Location = distance from stop bar edge closest to detectors to beginning of detectors

**Figure 4 – Vehicle Detector Placement for High-Speed Intersection Approach (55-70 MPH)**



Notes:

1. Each detector group shall have a separate homerun cable and amplifier channel.
2. No more than 4 detector loops shall be hooked up to the same homerun cable or amplifier channel on a minor street & no more than 6 loops on an arterial street.

**DETECTOR FUNCTIONS:**

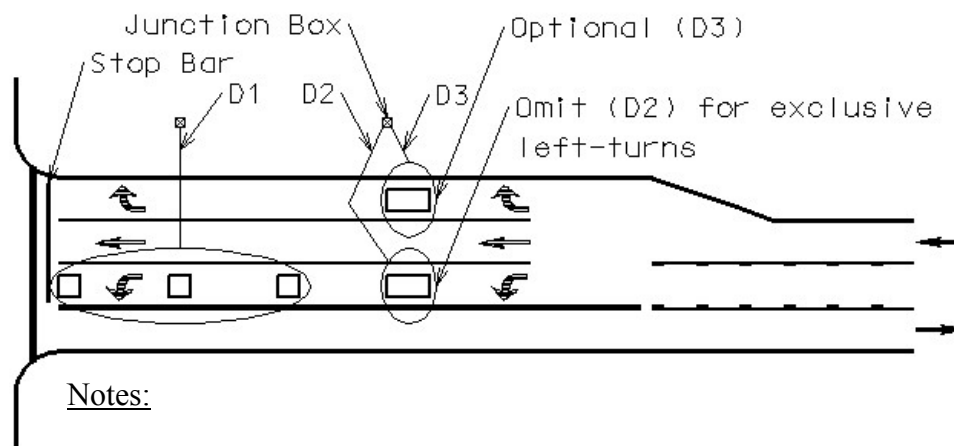
A = Normal or Standard

B = Stop Bar with Extend Timer Reset

SPEED (MPH)	LOCATION				DETECTOR GROUP #	DETECTOR FUNCTION	INDUCTANCE LOOP SIZE
	D1	D2					
55	3'	140'	270'	400'	D1	B	6' x 6'
60	3'	195'	335'	475'	D2	A	6' x 6'
65	3'	240'	395'	550'			
70	3'	295'	460'	625'			

Location = distance from stop bar edge closest to detectors to beginning of detector

**Figure 5 – Vehicle Detector Placement for Left & Right Turn Intersection Approach**



1. Each detector group shall have a separate homerun cable and amplifier channel.
2. No more than 4 detector loops shall be hooked up to the same homerun cable or amplifier channel.
3. Omit the queue detector (D2) for protected-only left turns.
4. For double left turn lanes, group the back 4 detectors separate from the front 2 detectors.
5. Queue Detectors (D2 & D3) should have a 2-3 second delay.
6. Queue Detector (D3) for the right-turn lane should generally be omitted, except in any of the following situations:
  - a. The right-turn is the critical lane group for the phase.
  - b. There are sight distance restrictions making a right-turn-on-red difficult.
  - c. There are significant times of the day with insufficient gaps in merging traffic.

**DETECTOR FUNCTIONS:**

A = Normal or Standard

LOCATION				
D1			D2	D3
3'	19'	35'	51'	51'

DETECTOR GROUP #	DETECTOR FUNCTION	INDUCTANCE LOOP SIZE
D1	A	6' x 6'
D2	C	6' x 12'
D3	C	6' x 12'

C = Extend/Delay

Location = distance from stop bar edge closest to detectors to beginning of detector

**Conductors:**

All loops 6 ft. x 12 ft. and smaller consist of four turns of single conductor No. 14 AWG wire. **No twists are allowed in the loop itself.**

**Saw-cut Loop Installations:**

Single conductor No. 14, stranded, polyethylene/nylon insulated wire, enclosed in a loose fitting polyethylene duct (IMSA 51-5). Twist the lead-in from the loop to the junction box at least 1 turn per foot (extra saw cut width is required to accommodate the twisted wire).

**PVC Conduit Loop Installations:**

Single conductor No. 14, stranded cross-linked polyethylene insulation type XHHW, IMSA Spec. 51-3 wire. Twist at least 3 turns per foot in the lead-in, from the loop to the pull box.

**Home Runs:**

Two conductor No. 14 twisted pair cable running from the detector loop splice/junction box to the controller (Spec. IMSA 50-2).

**Additional Detector Loop Design Criteria:**

- Intersections that involve the installation of new asphalt or concrete paving provide an opportunity to place detector loops beneath the pavement, in the top layer of road base. Detectors needed for future use, both number and placement, should be considered while the opportunity is there for them to be placed under the new pavement.
- Install queue-loops when the 5-year traffic projections indicate left-turn phasing will be warranted. Left turn signal heads will only be installed when warrants are met.
- Most traffic signal cabinets are ordered with only one detector rack (4 detector amplifiers with up to 4 channels on each amplifier – 16 channels). If more than 16 channels are needed, order the traffic signal cabinet with two detector racks.

- For the new detector design, in order to minimize detector cross talk between detectors on the same approach, it is recommended to group detectors on the same approach to the same detector amplifier. Each detector amplifier has 4 channels. The convention (to the right) should be used for each detector amplifier. (Example: Detectors assigned to phases 2 & 5 should be on the same amplifier.)

Detector Phase Assignment								
Detector	Phase Assignment							
	1	2	3	4	5	6	7	8
1					X			
2		X						
3		X						
4		X						
5	X							
6						X		
7						X		
8						X		
9							X	
10				X				
11				X				
12				X				
13			X					
14								X
15								X
16								X

Detector Amp #1  
 Detector Amp #2  
 Detector Amp #3  
 Detector Amp #4

WB /  
 SB /  
 EB /  
 NB

WB  
 EB  
 NB  
 SB

### Loop Installation Methods:

**Saw Cut Installation** – Use when concrete surface exists or where newer asphalt surface exists that shouldn't be marred by trenching.

**Trenching Installation** – Use to get the loops below the asphalt surface that tends to move or rut for enhanced durability. Trenching must be used in pavements which are in poor condition or which are likely to receive an overlay of new asphalt. Trenching must be calculated separate from the conduit and conductor since one trench will hold multiple conduit and conductors.

### Home Runs from Junction Box to Controller:



The limitation to combining four loops for a home-run on the minor street is to assure adequate sensitivity to detect motorcycles. This traffic movement is not intended to be served in every cycle and will be skipped when no vehicles are sensed. Major traffic movements are "recalled" and given the green signal in all cycles. Detection missing a small vehicle is of little consequence on a recalled phase. Missing these vehicles (not giving a green phase) in a left turn, or a minor cross street, can become very serious.

## 3.5 RELATING DETECTOR LOOPS TO SIGNAL PHASING

It is important to utilize a standard numbering system that will provide a consistent way of referencing detector loops for the designer, contractor, and technician working in the cabinet.

UDOT has adopted the National Electrical Manufacturers Association (NEMA) traffic signal phase conventions. The standard NEMA detector loop numbering associates each detector to its signal phase. Figure 1 illustrates the NEMA assignment and UDOT conventions to be used.

When the **major street runs north and south**, **phase 2** is assigned to the northbound through traffic and the associated detector loops.

When **east/west is the arterial**, **phase 2** is assigned to the westbound through traffic (all phases are rotated counter-clockwise 90 Degrees).

When **both roads are major highways**, phase 2 is assigned to the northbound traffic.

- Through phases are numbered clockwise with even numbers.
- Left-turn phases are numbered clockwise with odd numbers, starting with the movement that is opposite phase two.

When dedicated left-turn phases are used the NEMA phase preceding each through movement is used for the left turn (leading-left-turns). For example, Phase 1 will be assigned to the left-turn movement opposing phase 2.

The detector loop schedule indicates the assigned home-run cable and grouping assignment for each loop in the "remarks" column.

**Detector Loop Numbering:**

Syntax to be used: **(P)(U)(n)(z)**.

**P** = NEMA phase number

**n** = number for the loop in that group

**U** = loop use (alphabetic)

**z** = home run group alphabetical identification

**Loop Use (U)**

**T** = Through / (Right)

**L** = Left movement

**D** = Dilemma zone

**Q** = Queue detectors, left, right or backed-up through

**S** = System Loops

For example, assuming a separate home run for the front loop(s):

Phase 1, front loop would be 1L1a

Phase 1, second loop back would be 1L1b

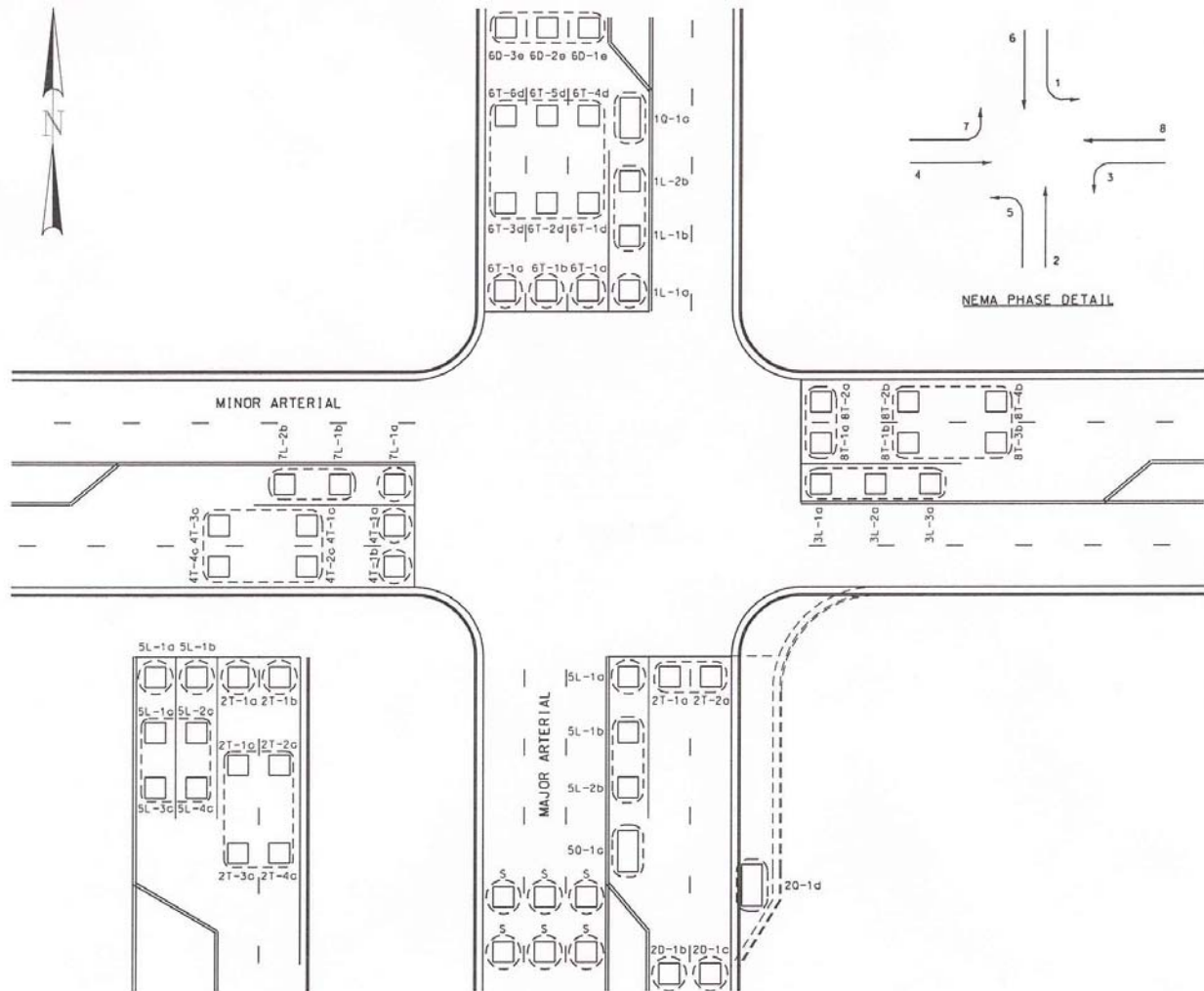
Phase 1, third loop back would be 1L2b

Phase 1, Queue loop, would be 1Q1c

Numbering starts at the stop bar, nearest the centerline, ascending toward the curb and increasing in value away from the intersection for each phase of the leg. The first loop of a group takes number 1 (one) and the Home Run Alpha Designation (a,b,c,...) for the group it is in. The Left-turn and Through movements for each leg will have an "a" home run.

Assign the System Loops ("S" prefix) in numerical sequence. The designer may include additional characters that further designate system detector loop options.

### 3.6 NEMA PHASE DETAIL



### 3.7 LUMINAIRE EXTENSIONS

Place signal pole luminaire extensions at opposite corners over the major roadway 90 degrees from the mast arm unless there is a conflict with overhead utilities. Typically two luminaires are specified per intersection. Large or remote intersections may require up to four luminaires. Specify the following:

- Use 15' luminaire arm length if possible. 10' luminaire arm is also available.
- Use High-Pressure Sodium (HPS) lamps, 250 Watt or 400 Watt.
- Use Full Cut-off Luminaires with Type III distribution, 240 Volt single-phase.



Consider the lamp wattage specified based on the intersection location circumstances. Balance illumination needs with the surrounding environment. If the highway lighting is provided along the corridor, provide 50% greater illumination at the intersection. Refer to the UDOT lighting guidelines and RP-08 for additional information.

Intersections with **video detection** require four luminaires to provide adequate illumination for the cameras. Refer to the Video Detection Section of the Guideline.

### 3.8 LANE LINES AND INTERSECTION STRIPING

#### Lane Striping

Show lane striping for the intersection and clearly identify the dimensions and distances required for proper installation. Also indicate the material to be used (tape or paint). Call out any striping removals to avoid motorist confusion once the intersection is opened up to traffic. Show existing striping in a gray scale on the plan sheets.

#### Pavement Markings

Match existing pavement striping materials. If existing tape is used through the intersection, then replace the markings with tape. Please be aware of this during the design process and specify the material in the design plans.

### 4.0 CIRCUIT DESIGN

#### 4.1 SIGNAL CIRCUITS

##### Power Source:

The designer should contact the Region Utility Engineer to request a Work Order from the local power utility and arrange for the power connection. Typically a meeting is scheduled in the field at the signal location. The power source can be from an underground service pedestal, a pole mounted and meter/disconnect service, or a transformer. Refer to Standard Drawings SL 3 and SL 6.

**Specify an underground service pedestal** if: 1) the local Utility Company requires it; 2) the pole mounted meter/disconnect is not easily accessible or easily located; or 3) the distance is greater than 150 ft. from the controller and is not easily visible.

Use the proper wire size determined from voltage drop calculations made for the intersection.

The calculation includes both the distance from the service to the controller, and back to the service. Minimum acceptable wire size for UDOT projects is No. 6 AWG cable.

Provide three single conductor No. 4 AWG copper RHH-USE-RHW, plus a ground wire from the power source to the underground service pedestal. Use two single conductor No. 6 AWG copper RHH-USE-RHW, plus a bare copper ground wire from the underground service pedestal to the controller cabinet. Black wire is to be used for the "Hot Wire" and White for the "Neutral Wire."

**Traffic Signal Heads**

7-Conductor No. 14 AWG, Stranded Cable, Spec. IMSA 20-1 (120 volts).

**Near side (and other single) Traffic Signal Heads**

4-Conductor No. 14 AWG, Stranded Cable, Spec. IMSA 20-1 (120 volts).

**Pedestrian Signals**

7-Conductor No. 14 AWG, stranded cable, Spec. IMSA 20-1 (120 volts).

**Street Lighting**

2-Single conductor No. 6 AWG, stranded wires and bare copper ground wire, No. 6 AWG minimum. Larger wire must be used when voltage drop calculations show drops greater than 5% of supply line voltage, Spec. (IMSA 51-1).

Approved waterproof splices may be used in the bases or pull boxes of street lighting circuits. No splicing is allowed elsewhere. Pull-apart molded fuse connectors are required in all light poles (except signal poles with luminaire extensions).

**Pedestrian Push Button**

4-Conductor No. 14 AWG, stranded cable, Spec. IMSA 20-1 (low voltage).

**Signal Detection Home-Run**

2-Conductor No. 14 AWG, shielded and stranded twisted pair, Spec. IMSA 50-2 (low voltage). Label each end of home run.

**Loop Wire**

Saw-cut slot applications, Spec. IMSA 51-7 (low voltage).

Trenched PVC Conduit, Spec. IMSA 51-3 (low voltage).

**Video Detection**

Power Requirements for all Brands of Hardware:

4-Conductor No. 14 AWG, stranded cable, Spec. IMSA 20-1 (120 volts).

Video Cable Requirements for Peek and Iteris Hardware:

Belden 8281 or equivalent coaxial cable (video), Spec. RG-59. Use for field run < 1000 ft. from pigtail connection at base of signal pole to controller cabinet.

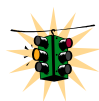
Video Cable Requirements for Trafficon Hardware:

Combined video coaxial/power cable provides splice free connection from camera to controller. State Furnished cable comes in 250 foot, 500 foot, and 1000 foot spools. Specify the

required length when placing State Furnished Material Requisition.

Video Cable Requirements for Econolite Hardware:

6-pair twisted No. 18 AWG, shielded cable Spec. IMSA 60-6 for video signal (low voltage).



### Interconnect Cable

No. 19 AWG, 6 pair, Spec. IMSA 60-6 (low voltage).

Fiber optic cable, 6 SMF minimum (refer to contact list regarding interconnect).

## 4.2 CONDUIT

Use schedule 40 PVC listed electrical conduit for underground signal installation. Use galvanized rigid steel (GRS) listed electrical conduit for above ground applications. Special considerations for Fiber-optic Cable installation are needed (refer to contact list for further details).

### Choosing the Right Conduit

The National Electric Code (NEC) requires no more than 40% of a conduit be filled with wire and cable. The cross-section of the wire (single conductor) or cable (multi conductor) varies depending on the type of insulation specified. Listed below are cross-sectional areas for the typical cables used, and the allowable area at 40% capacity for various conduit sizes.

**Example:** Choose the conduit size required to accommodate 6 detector home runs. The area of a 2-conductor No. 14 cable is selected and multiplied by 6 to obtain a total cable area of 0.831 sq. inches. Therefore the 2-inch PVC conduit is selected as the appropriate size.

Cable Cross-Sectional Area (sq. inches)		40 % of PVC Conduit Area Capacity (sq. inches)	
1-Cond. No. 6	0.1041	3/4 "	0.203
		1 "	0.333
2-Cond. No. 14	0.1385	1 1/4 "	0.581
		1 1/2 "	0.794
3-Cond No. 14	0.1589	2 "	1.316
		2 1/2 "	1.878
4-Cond. No.14	0.1105	3 "	2.907
		3 1/2 "	3.895
7-Cond. No. 14	0.2123	4 "	5.022

### Detector Loop Conduit

Use 3/4 inch for lane loops.

### Shared Usage

- Traffic signal heads, pedestrian signal heads, and video detection operate at 120 volts and may share conduit.
- Detector loop home runs and pedestrian push button are low voltage circuits and may share the same conduit. Provide separate conduit for video detection cable.

**Future Use**

Specify two future-use conduits, 2-inches in diameter, placed between all pole junction boxes and the controller cabinet. Place the future-use conduits on top of the other conduits in the trench. Include one continuous No. 14 AWG copper THHN pull wire in each future-use conduit. This wire is used to pull future wire and can also be used to locate the underground conduit run.

**Interconnect**

Use 1-D conduit to accommodate future fiber optics with Type II-PC junction boxes with 35' of slack at pull locations. Spice locations require Type III-PC junction boxes with 70' of cable slack. Space junction boxes 300 ft.  $\pm$  intervals. Use large radius sweep bends (3 ft. minimum) for fiber optic cable. Install a locator wire placed in a 1-inch PVC conduit. Refer to Standard Drawing AT 6 and AT 7.

**Video Detection**

Video power circuit shares the same conduit as the signal power. The video signal circuit shares the same conduit as the pedestrian push button detectors (as noted above). Do not combine video signal in the same conduit used for power. Combined video power/coaxial cable is placed in a dedicated 2" PVC video detection conduit.

## 4.3 JUNCTION BOXES

Specify only PC (polymer concrete) junction boxes for signal and lighting installations. Place individual, Type II-PC junction box at the base of each signal pole. Always specify a Type II-PC junction box when the Home Runs from more than one leg are being accommodated. The signal pole junction boxes may be eliminated when the cabinet junction Box is near the pole location. Specify a Type III-PC junction box at the controller cabinet.

**Shared Usage Power**

At the power source junction box the lighting and the signal circuits share the same junction box. From this point (or the underground service pedestal) no other mixing of these circuits is allowed (120 and 240 volts), except inside the signal poles. A separate conduit and junction box is required for 120 volt and 240 volt circuits.

Junction boxes for signal and pedestrian circuits are shared for both power and detection, the conduits however are not shared. These separate circuits are identified on the plans with the appropriate legend.

## 4.4 POWER SOURCE



**Verify the power source in the field with the serving utility company. List the name and phone number of the individual with whom connection will be arranged on the plans.**

Identify the location of the power source with station and offset and indicate whether it is a pole or ground-mounted transformer.

Coordinate with the local Region regarding agreement requirements with the local municipality for payment of the power for intersection street lighting, connection fees and maintenance. List the contact person's name and phone number on the plans. Remember to contact the UDOT Region Utility Engineer early in the design phase to coordinate the project service needs.

## 4.5 GROUND RODS

Use 10 ft. x 3/4 inch copper-clad steel UL Listed ground rod shall be installed through the control cabinet foundation in a PVC sleeve. Use a separate UL Listed ground rod, 8 ft. x 5/8 inch in the cabinet junction box driven to a depth so that not more than 6" remains exposed. Both rods are required, even when they are less than 6 ft. apart.

Use 8 ft. x 5/8 inch copper-clad steel UL Listed ground rod installed at each junction box that contains cables with 120 volt circuits or greater. In cases where these boxes are within 6 feet of each other, a single ground rod, located in the lighting box (when available) will suffice provided bonding conductors tie both grounding systems together. Please note the above exception at the controller junction box.

## 4.6 CONTROLLER AND CABINET



UDOT has adopted the new TS2 technology. Controller cabinets are referred to as "Size 5" and "Size 6". The "Size 5" will replace the old "M" cabinet and "Size 6" will replace the old "P" cabinets.

## 5.0 OTHER CONSIDERATIONS

### **Pedestrian Access**

Provide pedestrian access in accordance with Standard Drawing GW 5. Include Special Provision 02771M in the construction documents. This Special Provision includes information regarding three material options for detectable warnings (truncated domes), and ramp slope requirements.

## 5.1 TEMPORARY OPERATION

When modifications are made to an existing signalized intersection, care must be taken to provide for temporary power and signal control where necessary. Phasing of the new construction and demolition of the existing signal conduit and wiring must be given due consideration to insure proper function until it is no longer needed.

When alterations to the existing signal phasing or function or traffic lane assignments are proposed, an approved temporary signal operation/phasing plan is required.

Consider the use of contractor-supplied, temporary, above-ground detectors (video, microwave, radar, etc.) for maintenance of traffic during construction.

## 5.2 SIGNAL TURN-ON

When turning on a signal for the first time in a newly signalized intersection, consider the following methods to alert the public of this signal going into operation:

- Use a Portable Changeable Message Signs (CMS).
- Place the signal can be put into flashing mode for a short time; the most common

practice is to flash the signal up to 24 hours. This flashing mode should never exceed 72 Hours.

- Notify the local news media.
- Utilize the local law enforcement to draw attention to the change.

### 5.3 INTERCONNECT

Always consider the relevance of adjacent traffic signal interconnection up to ½ mile spacing. Where feasible, provide for coordination with a 1-D conduit designed to accommodate fiber-optic cable (large radius) installation.

Orient the direction of the 3” conduit stub in the cabinet foundation to accommodate fiber-optic installation. Refer to Standard Drawing SL 10.

### 5.4 SINGLE POINT URBAN INTERCHANGE (SPUI)

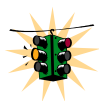
The SPUI has many unique features that need to be addressed in regards to the layout designed (under or over the freeway). When the SPUI is under the freeway the structure height restricts signal head clearance and sign placement. When the SPUI is placed over the freeway the support for signal heads and signing is critical and poor vertical sight distance is an issue. The following recommendations are presented for under and over, single and dual-lane SPUI configurations:

- Off-Ramp Left Turn Movement – Provide advance signals placed on the right side of the island. Place this signal head as far back up the ramp as practicable without confusing the right-turning vehicles. Use circular indications in all sections and do not use programmable heads. Consider using a second advance signal (circular indications) placed on the outer edge of the structure for the under freeway configuration.
- Left-Turn Signals – Provide circular red and yellow indications, with the green arrows tilted at 45 degrees up from horizontal.
- Left-Turn Movements onto the Freeway – Provide left-turn signs (R3-5) for clarification and lane assignment adjacent to each signal head. Use circular red and yellow with green arrows tilted up at 45 degrees from horizontal. The circular indication is used to give the needed target value in bright sunlight.

Interchange lighting should be placed in the SPUI to ensure the entrances to freeway on-ramps are well lit and visible from the stop bar.

A qualified structural engineer should design the overhead signal bridge structure. Standard tenons are used to mount the signal heads to the signal bridge. Include a detail of the signal bridge and identify the tenon locations to insure proper signal head placement in relation to the traffic lanes. Backer plates for the signal heads will be necessary but may be influenced by the size and height of the support structure.

## 5.5 VIDEO DETECTION



Video detection has become more reliable in recent years and is now being used as a temporary and permanent replacement for detector loops. Video offers flexibility to both the designer and constructor alike. Good cases for the use of video detection include a new signal or upgrade to an existing signal: after recent paving operations; when roto-milling operations are scheduled in the near future; or during construction phasing operations and ultimately for the permanent installation. Consider Specify video detection only under the approval of the project manager, Region Traffic Engineer, or Division of Traffic and Safety Design Engineer.

### Site Survey

Always perform a site survey to check for anything that might block the field of view or impact vehicle tracking such as trees, overhead wires, and commercial light sources.

### Camera Placement

Position video cameras on the signal mast arm utilizing 46-inch vertical pole with mounting bracket. The bracket is an astro-brac or equivalent connection to the mast arm and is very stable. If mounting on the luminaire, the choice between a right-side or a left-side luminaire mount is dependent on the phase sequence used to control the subject approach. For approaches without a left-turn phase, the camera is mounted on the right-side far corner of the intersection. For approaches with a left-turn phase and bay the camera is mounted on the left-side, far corner of the intersection. This location minimizes false calls for service to the left-turn phase. A delay setting should be used for the left-turn detectors to prevent unnecessary calls by departing vehicles. (Only consider the placement on the luminaire under the approval of the project manager or Division of Traffic and Safety). The ideal location of the video camera is placement on the mast arm.

Locate the camera on the mast arm so that it is centered over the opposing left and through lanes. This will ensure good field of view of the vehicles at the stop bar detection zone. A minimum camera height of 20 feet is recommended in recognition of the dirt, spray, and mist that can collect on the camera lens at lower heights. Position the video camera on the mast arm no greater than 25 feet above the road surface so to allow the UDOT region personnel the ability to reach the cameras from their boom trucks.

### Video Detection Zones

Video detection should not be used to monitor vehicle presence at distances greater than 250 feet from the video camera. The “rule of thumb” is that you can reliably detect 10 feet for every 1 ft. above the pavement surface the camera is placed, to a maximum distance of around 300 feet (250 feet for 25 ft. heights). For detection distances greater than 250 feet from the video camera, either a separate pole with a video camera will need to be placed upstream of the intersection or loop detection should be used.

The placement of detection zones for video detection should be the same as loop detection for distances between 100 feet from the stop bar up to 250 feet from the video camera. The detection zone length should approximately equal that of an average passenger car.

Stop bar detection zones (within 100 feet from stop bar) will vary depending on the video detection manufacture and intersection geometrics.

If advance detection is used, the stop bar detection zone should have the stop bar with extend timer reset function enabled.

Pay special attention to the passage time (vehicle extension time) when using video detection. Depending on the zone layout at the stop bar, it is not uncommon to use 0.0 seconds. In addition, it may be necessary to use the delay settings. The delay settings are sometimes used to reduce the frequency of unneeded calls. Specifically, a few seconds of delay is often set on the detectors in the stop-line detection zone of each minor-road approach. This setting offers two benefits. First, it eliminates false calls to the minor-road phases by major-road vehicle headlights (such as when a major-road vehicle makes a right turn and its headlights sweep across the minor-road stop-line detection zone). Second, it eliminates false calls to the minor-road phases by tall major-road vehicles.

During the initial video detection setup, the detection zone length should be measured along the roadway with a distance wheel. The most distant upstream edge should be marked with a traffic cone placed on the outside edge of the traveled way.

### **Luminaires**

Place signal pole luminaire extensions at each corner of the intersection to provide good lighting for video detection. Locate the luminaire extension arm perpendicular to the plane of the signal mast arm. This provides good lighting over the detection zone.

- Use 400 Watt luminaires for large intersections in commercial or industrial areas.
- Consider reducing the luminaire wattage to 250 Watt for smaller intersections in commercial or residential areas.
- Use 15 ft. luminaire arms especially when mounting video cameras.
- Refer to the Luminaire Extension Section of the Guideline for details regarding the luminaire.

## **5.6 MISCELLANEOUS**



Please contact the Division of Traffic & Safety if you have any questions regarding this guideline or how it applies to the project that you are working on (refer to Contact List in the appendix). We encourage the designer to contact us early in the design process to discuss standard UDOT intersection design and specific issues regarding your project. Early interaction expedites the design process and helps lead to the successful completion of the project.



## APPENDIX

### A.1 STANDARD SIGNAL REFERENCE

**Mast Arm Lengths (available in five-foot increments):**

30' through 55' one-piece, curved mast arm

60' through 65' two-piece, curved mast arm

70' and 75' two piece, straight mast arm

**Light Pole Extensions:**

Mounting Height: 30' and 40'

Arm Length: 10' and 15'

**Mast Arm Mounted Signs:**

R10-12, R10-11a 24" x 30"

R3-8 30" x 30"

Street Name Signs 60", 72", or 84" x 16"

**Anchor Bolt with Hardware (four required per pole)**

Signal Poles 2-inch diameter bolts

45' CCTV Poles 1.5-inch diameter bolts

40' Highway Luminaire Pole 1-inch diameter bolts

**Ground Rods:**

Junction boxes 8 ft. x 5/8 inch

Signal controller cabinet 10 ft. x 3/4 inch

**Other Reference Materials:**

- UDOT Standard Drawings and Specifications, Latest Edition.
- Millennium Edition of the MUTCD, 2000, FHWA.
- A Policy on Geometric Design of Highways and Streets, 2001, AASHTO.
- Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4<sup>th</sup> Edition, 2001, AASHTO.
- Manual of Traffic Signal Design, Second Edition, ITE.
- National Electric Code, 2002, NFPA
- An Informational Guide for Roadway Lighting, 1984, AASHTO.
- Roadway Lighting, IESNA, RP-08, 2000.
- UDOT CADD Standards, Latest Edition.
- UDOT Design of Highway Lighting: Guideline and Checklist, Latest Edition.

## A.2 CONTACT LIST

### DIVISION OF TRAFFIC AND SAFETY

Traffic and Safety Design Engineer	Larry Montoya	(801) 965-4924
Signal & Lighting Engineer	Vacant	N/A
Traffic Studies	Peter Jager	(801) 965-4264
Traffic Operations	John Leonard	(801) 965-4045

### REGION TRAFFIC ENGINEERS

Region One	Darin Duersch	(801) 620-1607
Region Two South Area	Ritchie Taylor	(801) 887-3717
Region Two North Area	Chris Siavrakis	(801) 887-3792
Region Two Signals	Deryl Mayhew	(801) 887-3605
Region Three	Doug Bassett	(801) 227-8019
Region Four	Troy Torgersen	(435) 893-4707

### TRAFFIC SIGNAL SYSTEM INSPECTION

Region One	Dale Lake	(801) 620-1606
Region Two	Troy Noall	(801) 887-3659
Region Three	Grant Jackson	(801) 227-8040
Region Four	Clay Cottam	(435) 590-9976
ITS (Fiber Optic Cable)	Craig Wright	(801) 887-3764
Statewide Training	Bill Butterfield	(801) 887-3748
	Rich Williams	(801) 887-3603

### STATE FURNISHED MATERIALS

Signal Hardware	Katie Knaus	(801) 965-4270
Signal Hardware Requisition	Amber Routson	(801) 965-4195
UDOT Warehouse Inventory	Doug Snedden	(801) 965-4755
UDOT ITS Hardware	Bob Pieper	(801) 887-3760
UDOT Sign Shop	Doug Fehrmann	(801) 965-4281

### SIGNAL SYSTEM COORDINATION

Statewide Coordination	Mark Taylor	(801) 887-3714
Statewide Technical	Keith Wilde	(801) 887-3708

## A.3 UDOT WEBSITE INFORMATION AND DOWNLOADS:

Standards and Specifications – Electronic Plan Room

<http://www.udot.utah.gov/index.php?m=c&tid=317>

CADD Documents – Standards

<http://www.udot.utah.gov/index.php/m=c/tid=77>

Traffic and Safety – Summary Sheets, Forms, and Guidelines

<http://www.udot.utah.gov/index.php/m=c/tid=579>

## A.4 STATE FURNISHED MATERIAL REQUISITION PROCESS

### Objectives:

- Save time and eliminate frustration.
- Materials available for project when requested.
- Simplify material pick up process for contractor.
- Eliminate handwritten over the counter requisition.

***Communication  
is the key!***

### UDOT Contacts:

Design Engineer or Consultant, Project Manager (P.M.), Resident Engineer (R.E.), and Contractor

#### Traffic and Safety –

Amber Routson, Secretary	965-4195	965-4736 fax
Katie Knaus, Engineering Intern	965-4270	
Larry Montoya, Traffic & Safety Design	965-4924	

#### Central Warehouse –

Warehouse Desk	965-4060	965-4818 fax
Doug Snedden, Inventory Mgr.	965-4755	
Tracie Montano, Supply/Materials Mgr.	964-4534	

#### Region Electronics Supervisor –

Dale Lake, Region One	620-1606	627-8196 fax
Bob Pieper, TOC/Region Two	887-3760	887-3797 fax
Grant Jackson, Region Three	227-8040	227-8049 fax
Clay Cottam, Region Four	(435) 590-9976	(435) 865-5564 fax

#### Sign Shop –

Doug Fehrmann, Sign Shop Mgr.	965-4281	964-4426 fax
-------------------------------	----------	--------------

## **How the Process Works**

### **Design Phase:**

#### **1. Design Engineer –**

- Contact Electronics supervisor early in the design process to determine the type and brand of controller required for each signal location and application.
- Finalize list of State Furnished Materials after PS&E review and prior to Final plan review. Minimize the likelihood of field changes.
- Submit one intersection per State Furnished Items Form.
- Email State Furnished Items Form to Amber Routson. Carbon copy the P.M., R.E., Katie Knaus, and Region Electronics Supervisor (Dale Lake, Bob Pieper, Grant Jackson, Clay Cottam).

#### **2. Amber Routson –**

- Print requisition forms. The State Furnished Items Form automatically creates five separate requisition sheets: 1. Signal Pole Materials; 2. Controller and Cabinet; 3. Video Detection/LED's; 4. Anchor Bolts; and 5. Misc. Signal Equipment (modem, astro-brac, signal heads, etc.) This final sheet will be used primarily for State Forces.

**Construction Phase:**1. **R.E. –**

- Provide Amber Routson with name of contractor, and approximate time-frame contractor will need State Furnished Materials after preconstruction meeting.

2. **Amber Routson –**

- Enter the requisition forms into FINET.

3. **R.E. –**

- Contact Katie Knaus approximately 2-3 weeks before materials will be picked up.
- Contact Region Electronics Supervisor approximately 2-3 weeks before cabinet is needed.

4. **Region Electronics Supervisor –**

- Contact Doug Snedden to schedule pickup date for signal controller and cabinet. 48-hours advance notice is required. *Note: Cabinet and Controller for Regions One and Four are typically shipped via weekly Region Transport.*

5. **Katie Knaus –**

- Meet weekly with Doug Snedden to review and update contractor schedule for material pickup.

6. **Contractor –**

- Contact Doug Snedden or Warehouse Desk to schedule a date and time to pick up materials from the warehouse. 48-hours advance notice is required.
- Contact Region Electronics Supervisor to schedule a date and time to pick up signal controller and cabinet from the Region signal lab.

**Material Return (Stock Return):**

1. **R.E. –**
  - Contact Katie Knaus with details of the change.
2. **Katie Knaus –**
  - Check availability of the item needed and relay this information to the R.E.
3. **R.E. –**
  - Complete Stock Return Transaction Form. Ensure all components are listed including hardware kits.
  - Fax completed form to Doug Snedden and carbon copy Katie Knaus.
4. **Contractor –**
  - Contact Doug Snedden to schedule date for material drop off. 48-hours advance notice is required.
  - Responsible for returning all items listed on the Stock Return Transaction Form.
5. **Warehouse –**
  - UDOT will not accept items that are missing components, used, or not packaged in the original box. Doug Snedden will contact the R.E. and inform him of materials not returned.
6. **R.E. –**
  - With hold Contractor retention until the items are returned or UDOT is reimbursed for the cost of the items missing.

**Tips for Completing the State Furnished Items Form:**

- R.E. – Provide contact information including name of the electrical contractor.
- Everyone – Check quantities:
  - Poles and mast arms
  - Anchor bolts for poles (four required per pole)
  - Video detection camera equipment
- Design Engineer – Specify signal controller and cabinet brands. Check with Electronics Supervisor or Keith Wilde at 887-3708, to determine the controller type and brand requirements for each signal location.
- Design Engineer – Submit request for ITS equipment (fiber interconnect equipment, ATMS cabinets, ramp metering) to Bob Pieper. R.E. – Follow up on request after preconstruction meeting.
- Contractor – Provide LEDs for traffic and pedestrian signal heads.
- Contractor – Submit request for mast arm mounted signs to Doug Fehrmann.
- R.E. and Contractor – Decide whether to drop ship the steel hardware (poles, mast arms, anchor bolts, etc.). This decision is based on feasibility and the construction schedule. Plan on 45-50 days to receive the shipment.
- Always double-check your order to ensure correctness before leaving the yard.

**Examples:**

**Case 1** – Contractor discovers unforeseen impact and needs to change the material listed on the initial requisition. Contractor has not picked up the materials yet.

1. **R.E.** –

- Contact Katie Knaus with details of the change including anticipated pick up date, etc.

2. **Katie Knaus** –

- Check availability of the item(s) needed and relay this information to the R.E.

Continue with step 2 listed under the Construction Phase.

**Case 2** – Contractor discovers unforeseen impact and needs to change the material he has already picked up. *This case involves returning material and requisitioning new material.*

1. **R.E.** –

- Contact Katie Knaus with details of the change including anticipated pick up date, etc.

2. **Katie Knaus** –

- Check availability of the item(s) needed and relay this information to the R.E.

3. **R.E.** –

- Email completed State Furnished Form to Amber Routson.

4. **Amber Routson** –

- Print the forms and enter the requisition into FINET.

Continue with step 3 listed under Material Return.

**Case 3** – Contractor informs R.E. that he is missing (or never received) an item that is State Furnished. If our records show that this item was picked up and not back ordered then the Contractor is responsible for this item. The R.E. will deduct the cost of these items from payment to the Contractor.

1. **R.E.** –

- Contact Katie Knaus with the details including what item is needed, and the anticipated pick up date, etc.

2. **Katie Knaus** –

- Check availability of the item(s) needed and relay this information to the R.E.

3. **R.E.** –

- Email completed State Furnished Form to Amber Routson.

Continue with step 2 listed under Construction Phase.